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Flood Control &
Water Conservation
DISTRICT



The San Francisco Bay-Delta Community Model

An Application at Eden Landing

Kees Nederhoff and **Stendert Laan** – October 28, 2025 – State of the San Francisco Estuary Conference

with Lauren Schambach, Rohin Saleh, Mick van der Wegen, Björn Rübke, and Andrew Stevens

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Background

Vulnerability of SF Bay

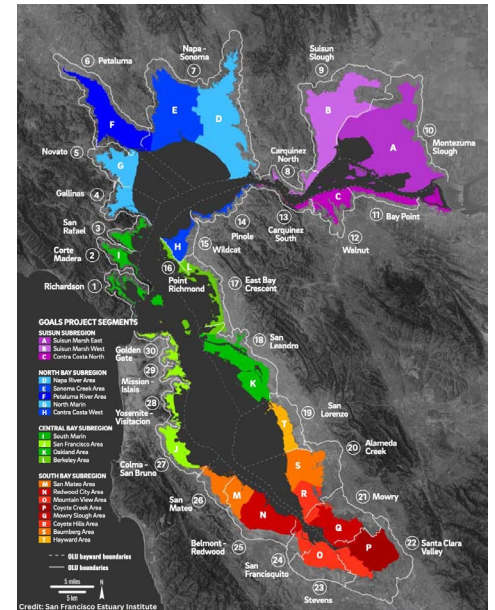
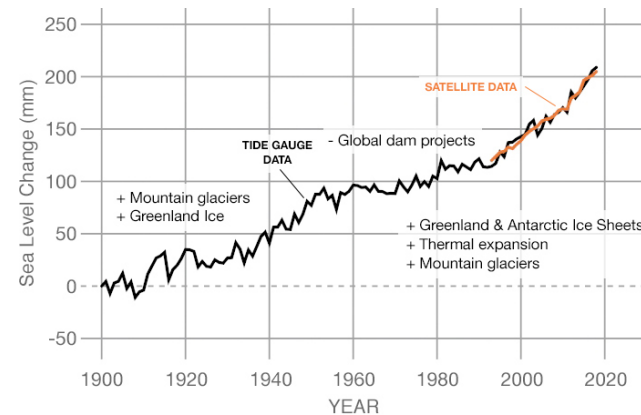
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Rising Risk: The Vulnerable Estuary

San Francisco Bay Under Pressure: Bay Area faces a perfect storm

- Sea level projected to rise 1-6 feet by 2100 (CA SLR Guidance 2024)
- Intensifying atmospheric river events (Wang et al., 2023)
- \$150 billion in property at risk by 2100 (Barnard et al., 2019)
- Critical infrastructure vulnerability (airports, highways)
- Environmental justice concerns in low-lying communities



An aerial photograph of San Francisco Bay, featuring the Golden Gate Bridge in the foreground and the city skyline in the background. A semi-transparent blue grid is overlaid on the entire image. The text 'Deltares USA' is prominently displayed in the center.

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The San Francisco Bay-Delta Community Model

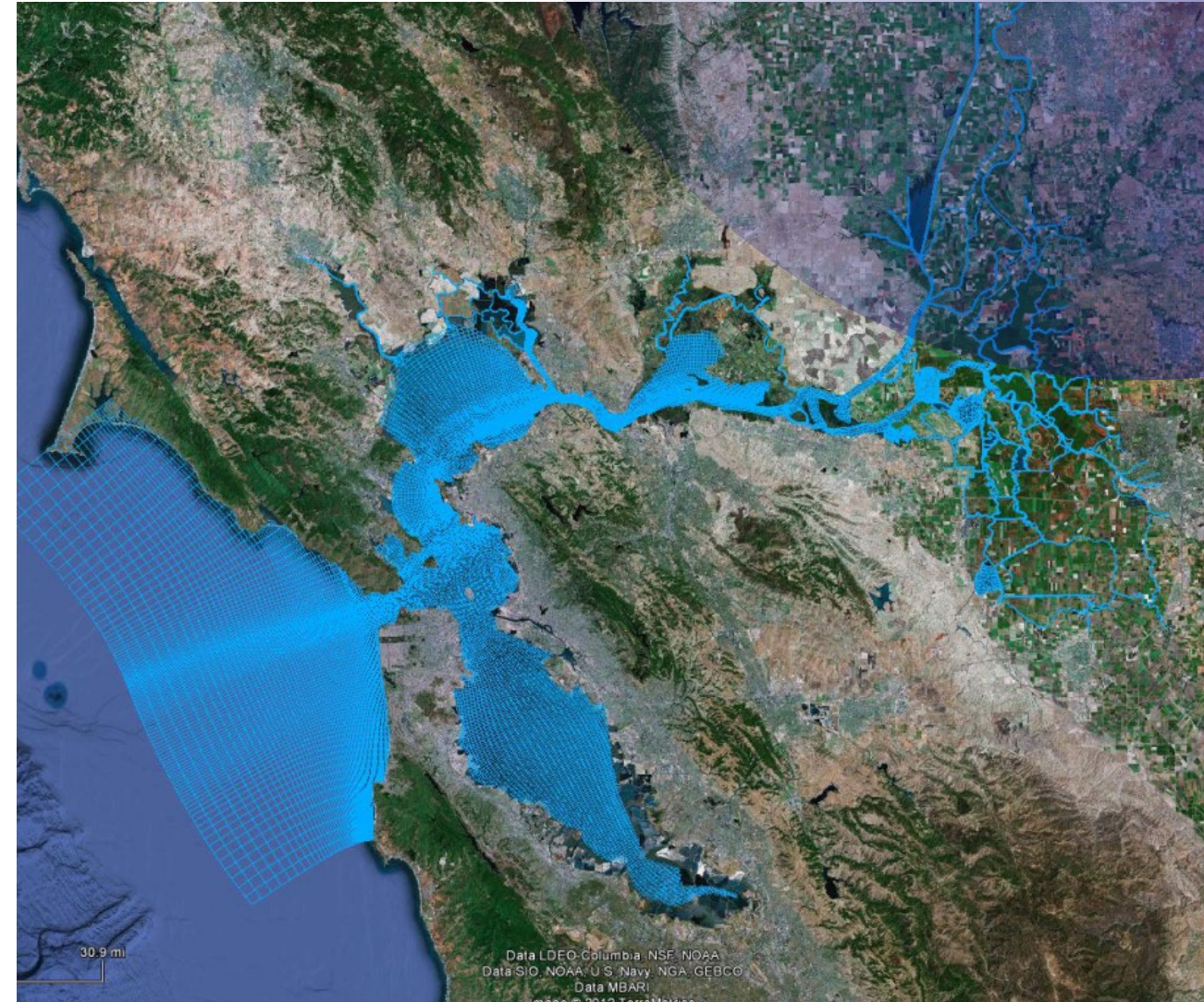
Development of Modeling Framework

Delft3D modelling of San Francisco Bay-Delta goes back to **2006** as part of USGS-Deltares science collaboration that goes back to ~2000

Delft3D FM is open-source and trusted by **30,000+ members** worldwide from academia to consultancy

CASCaDE: Computational Assessments of Scenarios of Change for the Delta Ecosystem

- Impact of *climate change* scenarios on San Francisco Bay-Delta eco-system with a 3D model (water quality, eco-systems, etc)
- **Funding:** 8 MUSD funded by CalFed and USGS (2011-2016)



Faster Alternative: Still Water Level Model

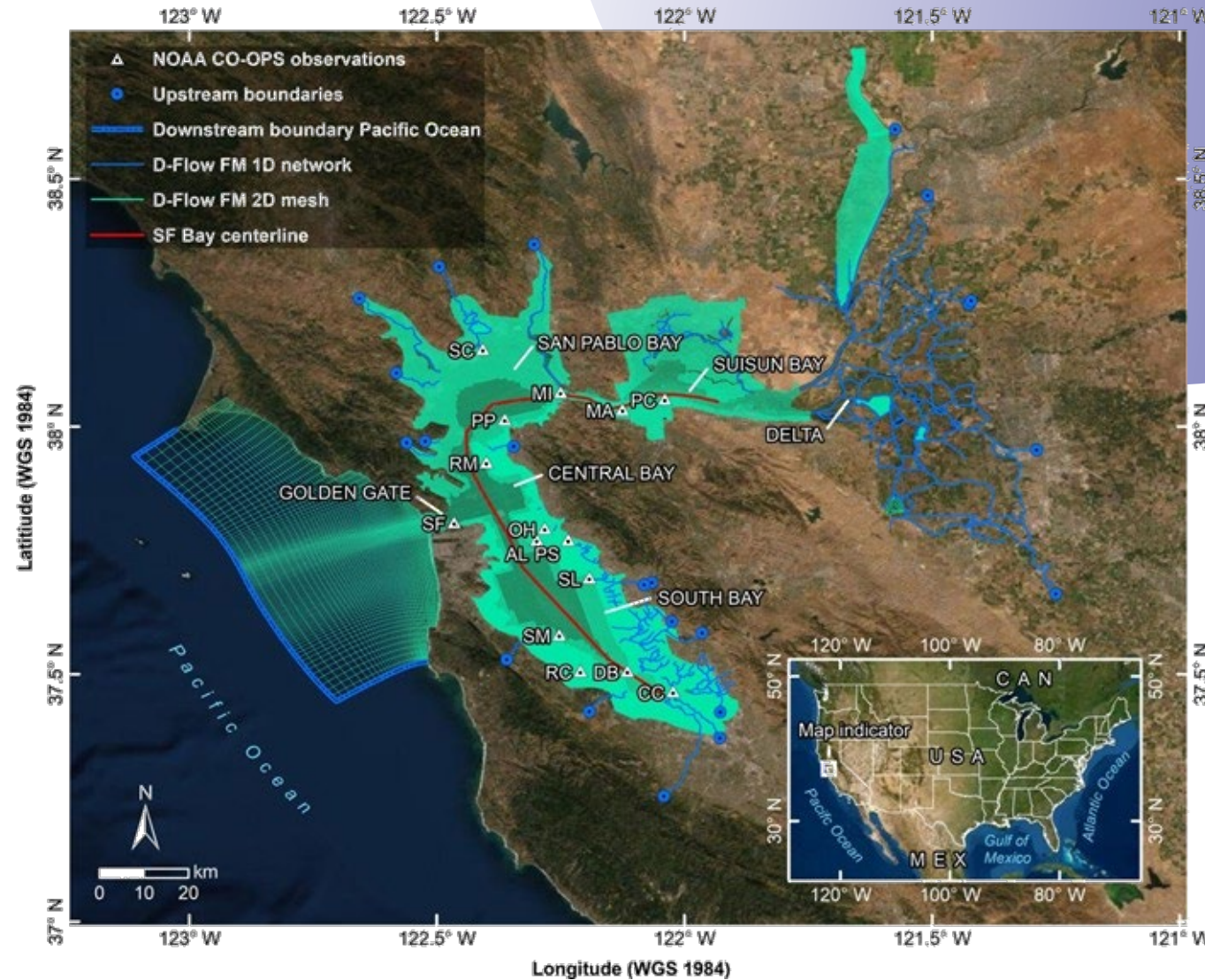
Relevant **engineering-scale** features included and **scientifically** peer-reviewed paper in Nederhoff et al. (2021)

Used operationally for **forecasting** of high-water levels by **NOAA** and **USGS** as part of the AQPI project

Model domain covers SF Bay and Delta and can thus be used for **regional** studies

1D-2D hydrodynamic model with subgrid features for efficient and accurate model simulations (RMSE of ~3 inches)

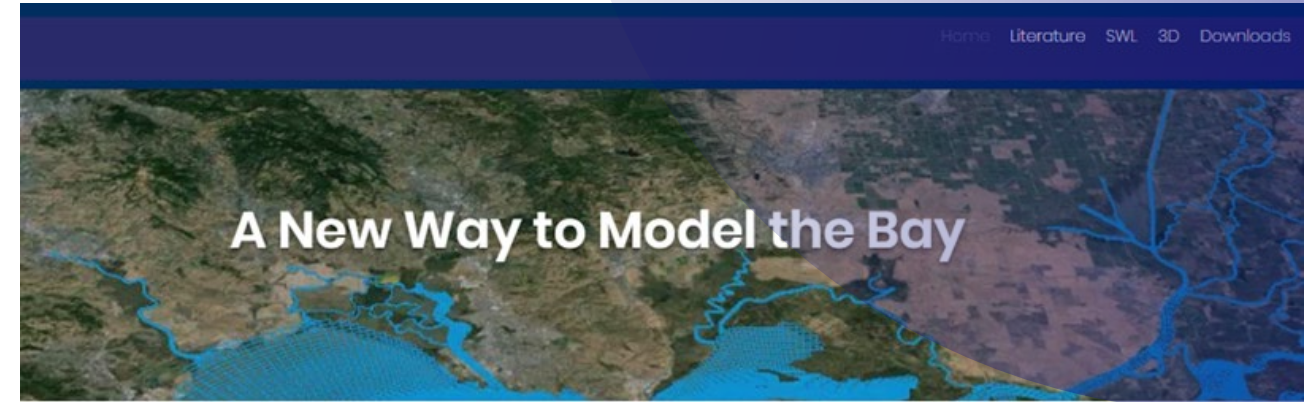
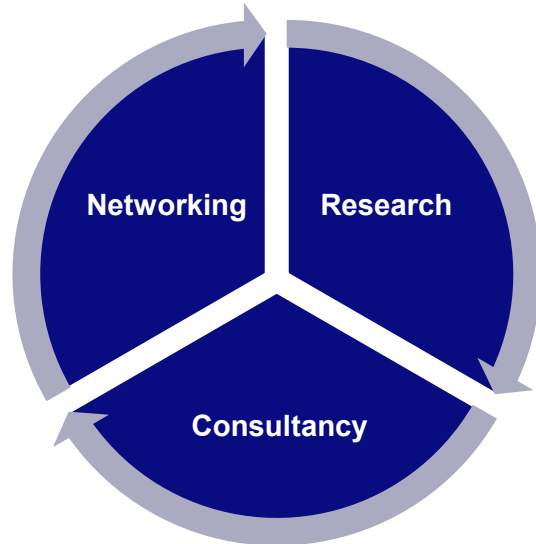
Reanalysis dataset by Deltares USA and ACFCD to perform **70-years** of continuous simulation for a robust estimate of extreme values and return periods statistics



Community Engagement: Launch of Online Platform

Community Platform: www.d3d-baydelta.org

The community model concept creates a **standard** model setup for everyone in which models and software are available **free of charge**



A powerful open-access platform is offered free-of-charge to scientists, engineers, and planners developing solutions to one of the biggest problems facing the Bay Area: sea level rise.

The San Francisco Bay-Delta is a complex natural environment. Modeling the dynamics that govern its water levels and quality is critical to addressing climate change and improving flood resiliency. Previous models of the Bay-Delta have not been free or accessible for public use, lack consistent data across regions, or require substantial technical knowledge to use.

About the San Francisco Bay-Delta Community Model

The **San Francisco Bay-Delta Community Model** employs a high-resolution LIDAR mesh connecting the San Francisco Bay and the Sacramento-San Joaquin River Delta, allowing for detailed analysis of hydrodynamics, including still water levels (SWL), tide, and surge for the entire ecosystem. This new, open-access, and easy-to-use model is offered free of charge for use by Bay Area agencies, academic institutions, and members of the public. The San Francisco Bay-Delta Still Water Level Model covers an area from Point Reyes, up to the tidal limits near Sacramento and Yreka.

Model Parameters

Due to its high resolution, the Still Water Level Model is limited to a one- and two-dimensional mesh. A separate three-dimensional (3D) Water Quality Model is also available. Because the 3D model uses a lower resolution mesh, it cannot be used for flood control purposes.

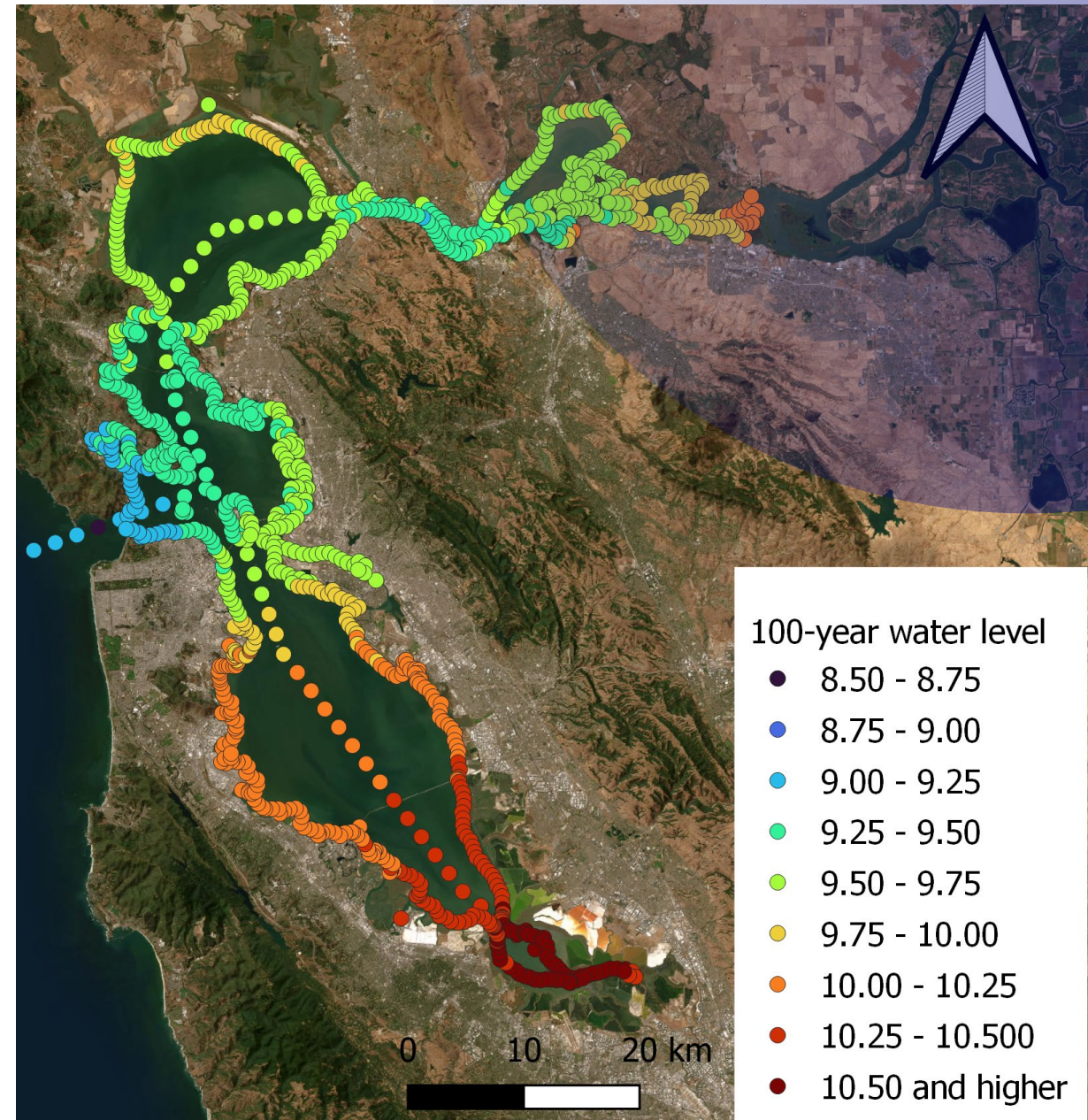
[2021] Uses a high-resolution mesh to model still water levels, tide and surge, and shoreline flooding.

[2017] Models water quality by simulating salinity, temperature, sediment concentration and

Community Platform: Content

- 1. Download the Model:**
grid, geometry, offshore boundary conditions, discharges, and wind forcing for WY1941-2024
- 2. Download processed model results:**
processed model results for 1244 points across the SF Bay for WY1941 - WY2024 (to use data without running model)
- 3. Download extreme, still, and total water level:**
includes shapefiles and analysis results across the SF Bay

Third parties can run, amend, copy, and distribute this SFBD-SWL and other SFBD Community Models under a Creative Commons Attribution-Share Alike 4.0 International License



Model Update: Overview of Components

Grid resolution scales with bathymetry

- 200m in Pacific to **50m in Baylands** and slough system (up to 20m elevation)
- grid in Delta aligned with channels, and **includes floodplains**

Compound topo-bathymetry based on multiple public sources

- national and state DEMs to local LiDAR
- **levees included** with varying crest height

Offshore boundary

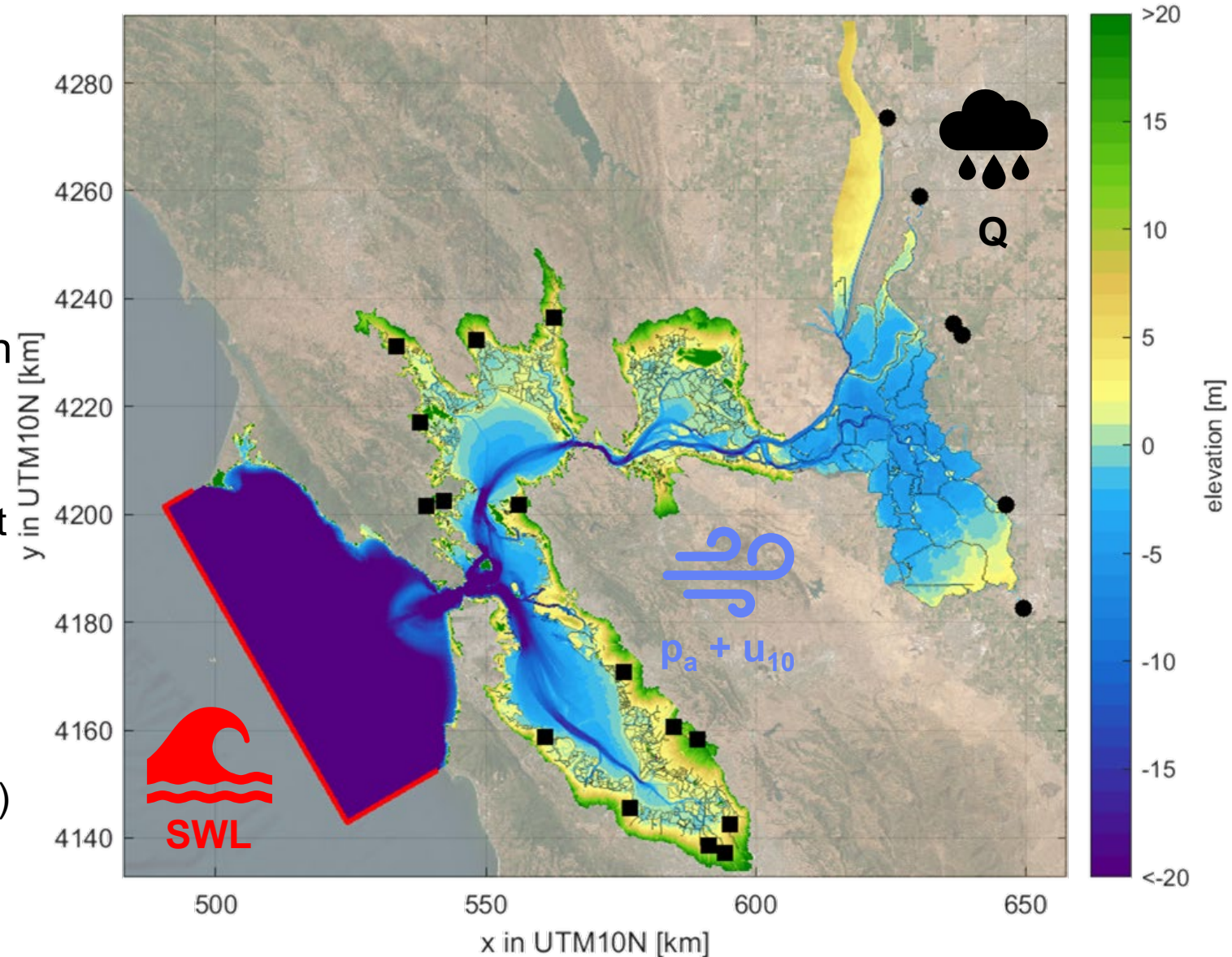
- Tides and Sea Level Anomaly

Meteorological forcing

- Wind and pressure from ERA5 (reanalysis)

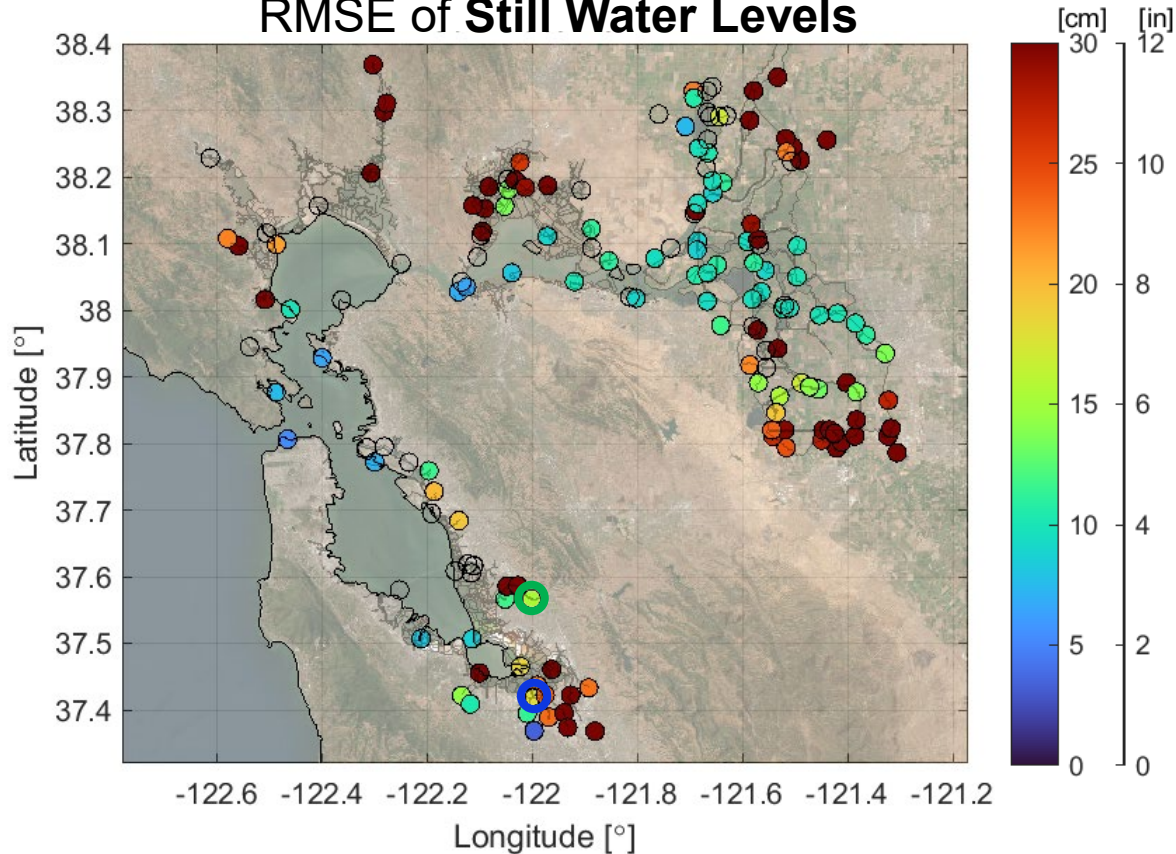
Discharges

- Observations from USGS' NWIS



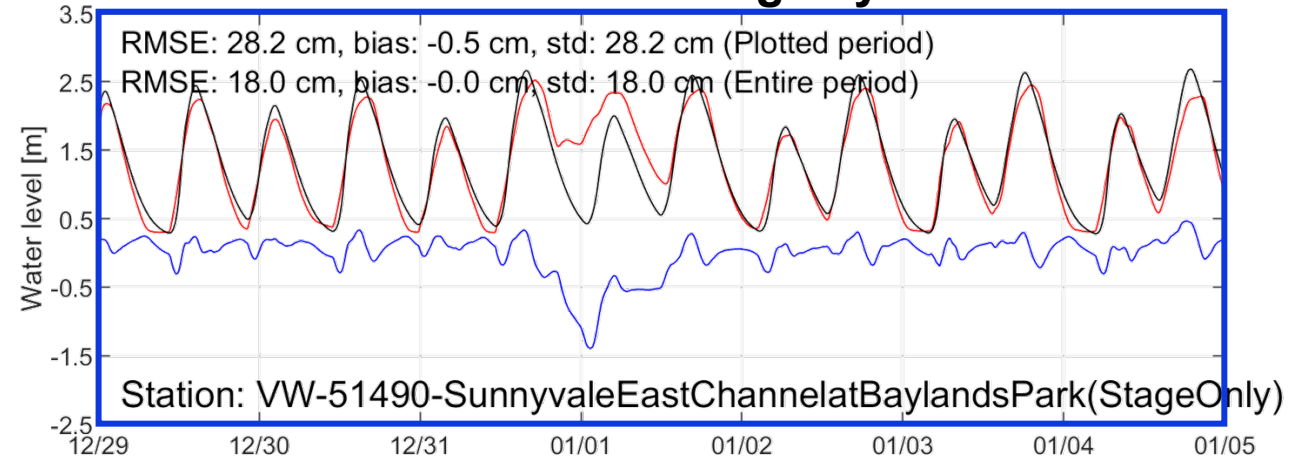
Model Update: Validation of Still Water Levels

RMSE of Still Water Levels

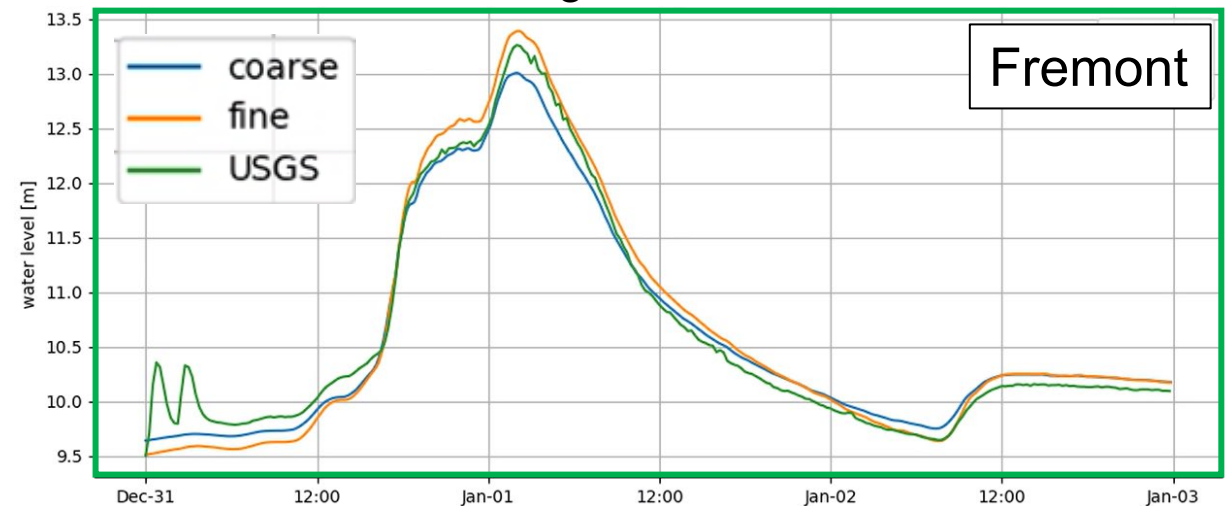


- **Good model skill** in Bay, Delta and at open coast
- Reasonably good skill in **upstream creeks and sloughs**, considering model grid resolution (50m)

Water levels in slough system



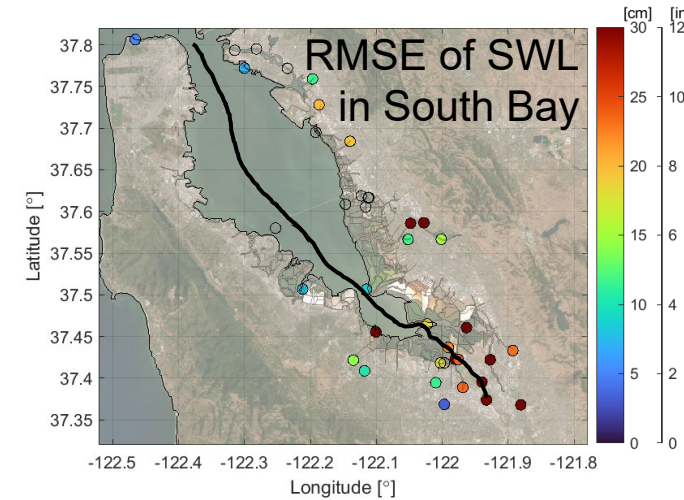
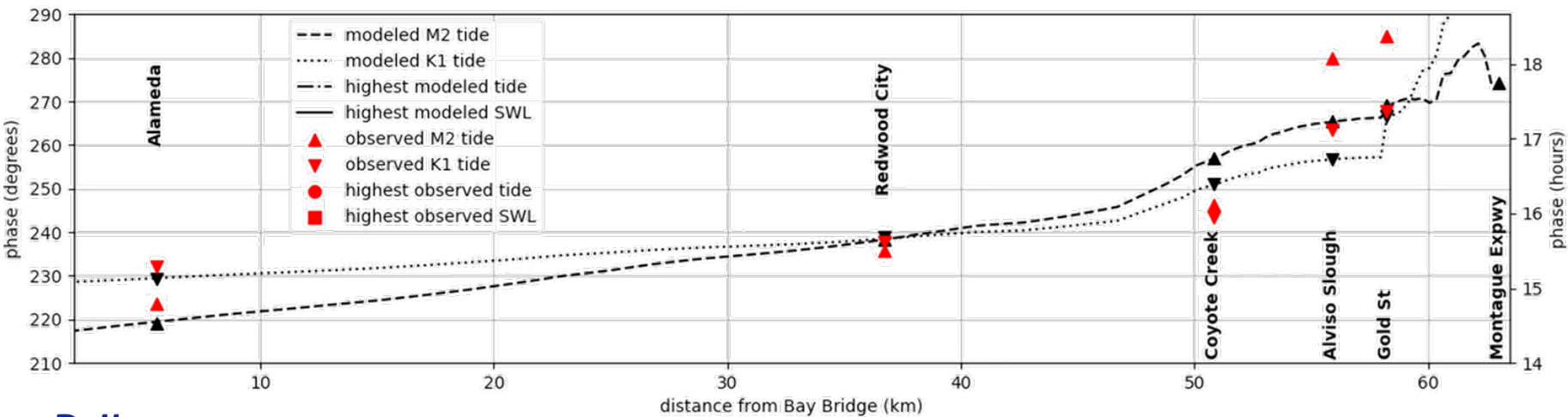
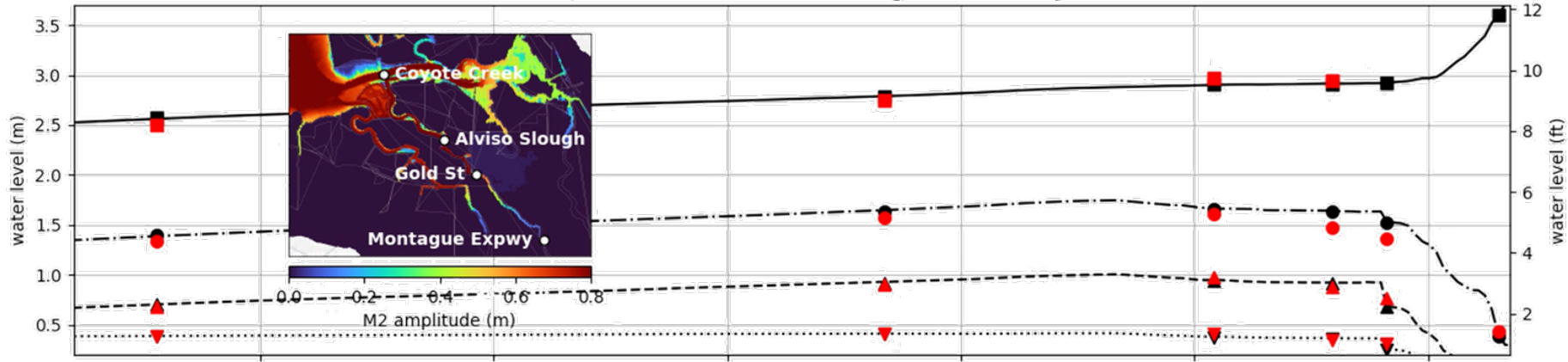
Water levels during storm event in WY2023



Model Update: Validation of Tides

- **Tidal amplification** in Bay and **damping** in slough system
 - **Riverine influences** take over (discharge events)

Water levels, M2 and K1 tides in Alviso Slough and Guadalupe River



Quantifying Flood Mitigation Strategies Under Sea Level Rise

Hard, Soft, and Hybrid Approaches
for San Francisco Bay

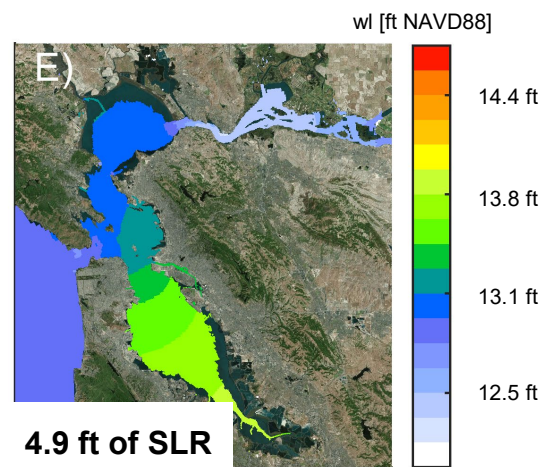
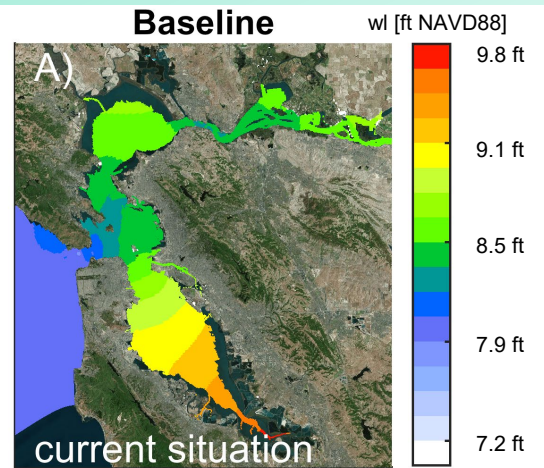
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From Modeling Framework to Adaptation

- **Bridging Science and Action:**
 - The open-access Community Model enables scenario testing for adaptation strategies
- **Three Pillars of Resilience:**
 - Wetland Restoration: nature-based buffering and carbon co-benefits
 - Shoreline Hardening: engineered protection of critical assets
 - Hybrid Solutions: combining structural defenses with ecological restoration
- **Objective:**
 - Quantify how these strategies mitigate water levels under sea level rise scenarios

How do the extremes change?



Want to learn more?

- Read the recent publication
 - Nederhoff, K., Saleh, R., Barnard, P., & Stacey, M. (2025).
 - “Mitigating Flood Risks in Urban Estuaries: Tidal Dynamics, Shoreline Hardening, Nature-Based Solutions, and Floodgates in San Francisco Bay.”
 - ASCE Journal of Waterway, Port, Coastal & Ocean Engineering.
<https://doi.org/10.1061/JWPED5.WWENG-2342>
- Explore results, datasets, and open models
 - Go to website www.d3d-baydelta.org

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Morphological Model for Tidal Wetland Restoration

A Case Study at Eden Landing,
San Francisco Bay

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Project Motivation and Study Area

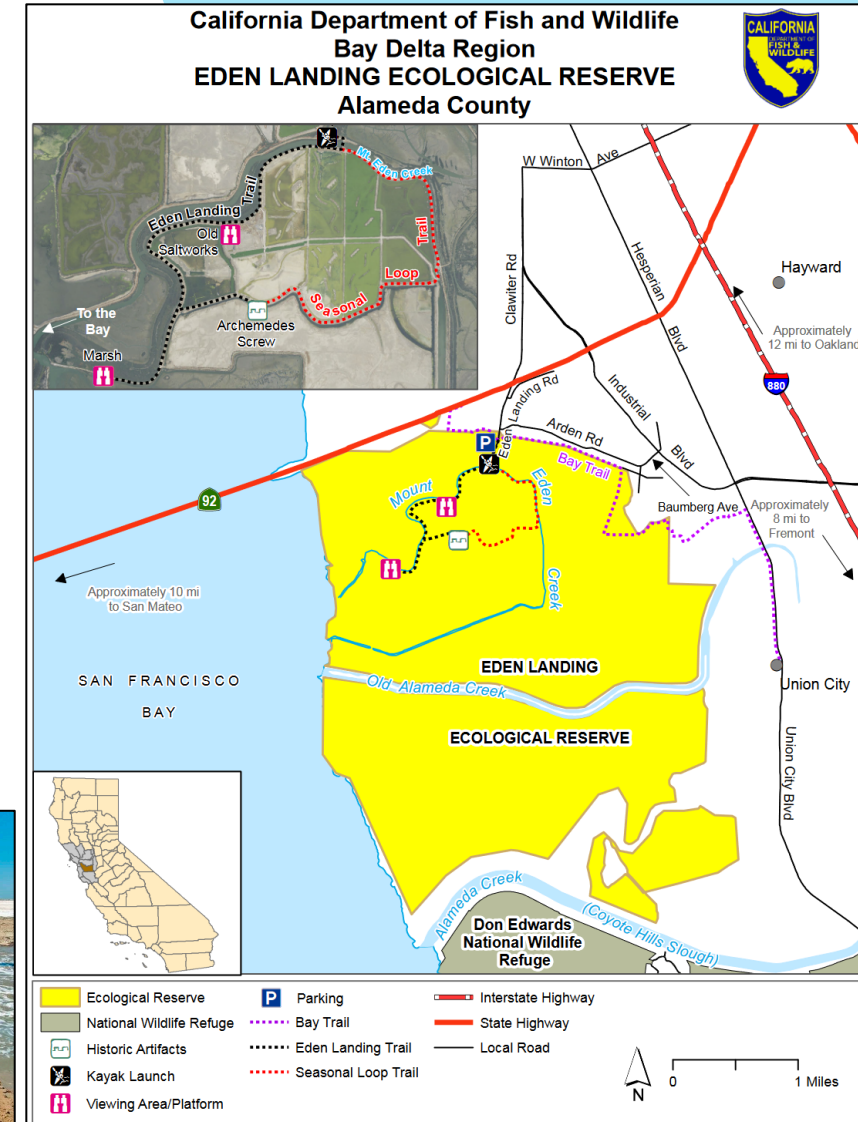
Eden Landing Ecological Reserve

- ~8,000 acres
- South-eastern shore of the San Francisco Bay

Lands acquired by California Department of Fish and Wildlife 2003

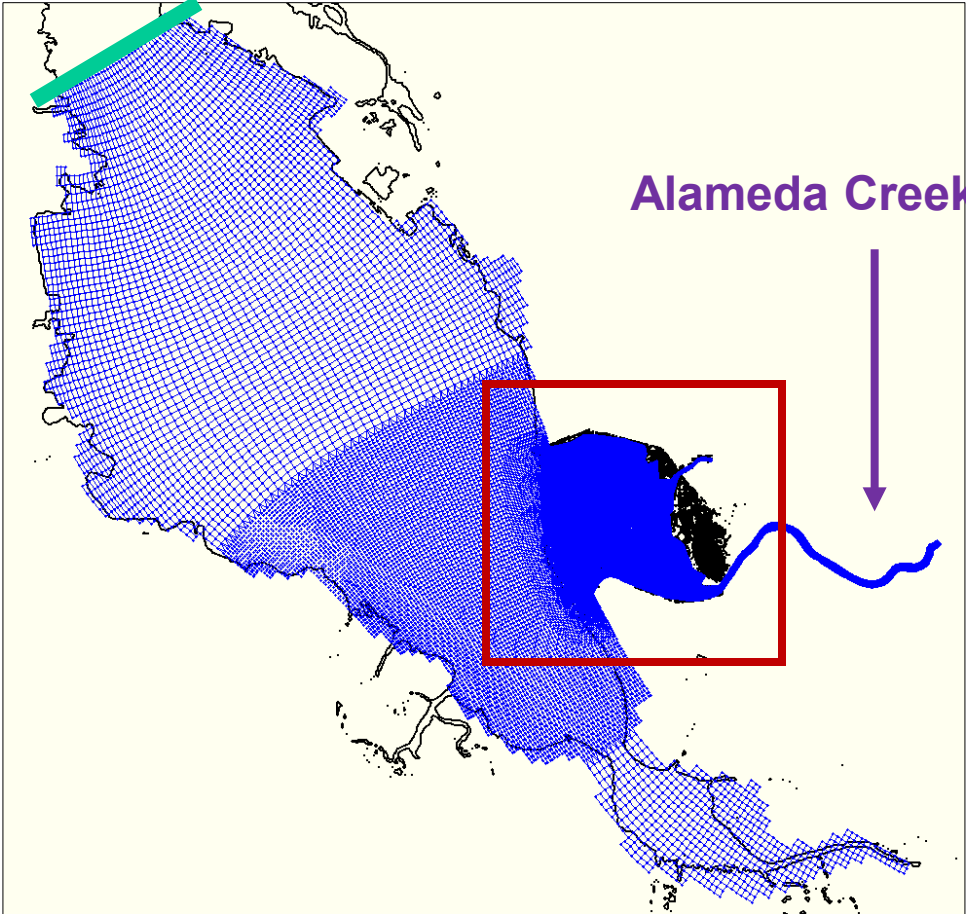
Part of the **South Bay Salt Pond Restoration Project**
(<https://www.southbayrestoration.org/>)

- Habitat restoration
- Flood management
- Wildlife-oriented public access

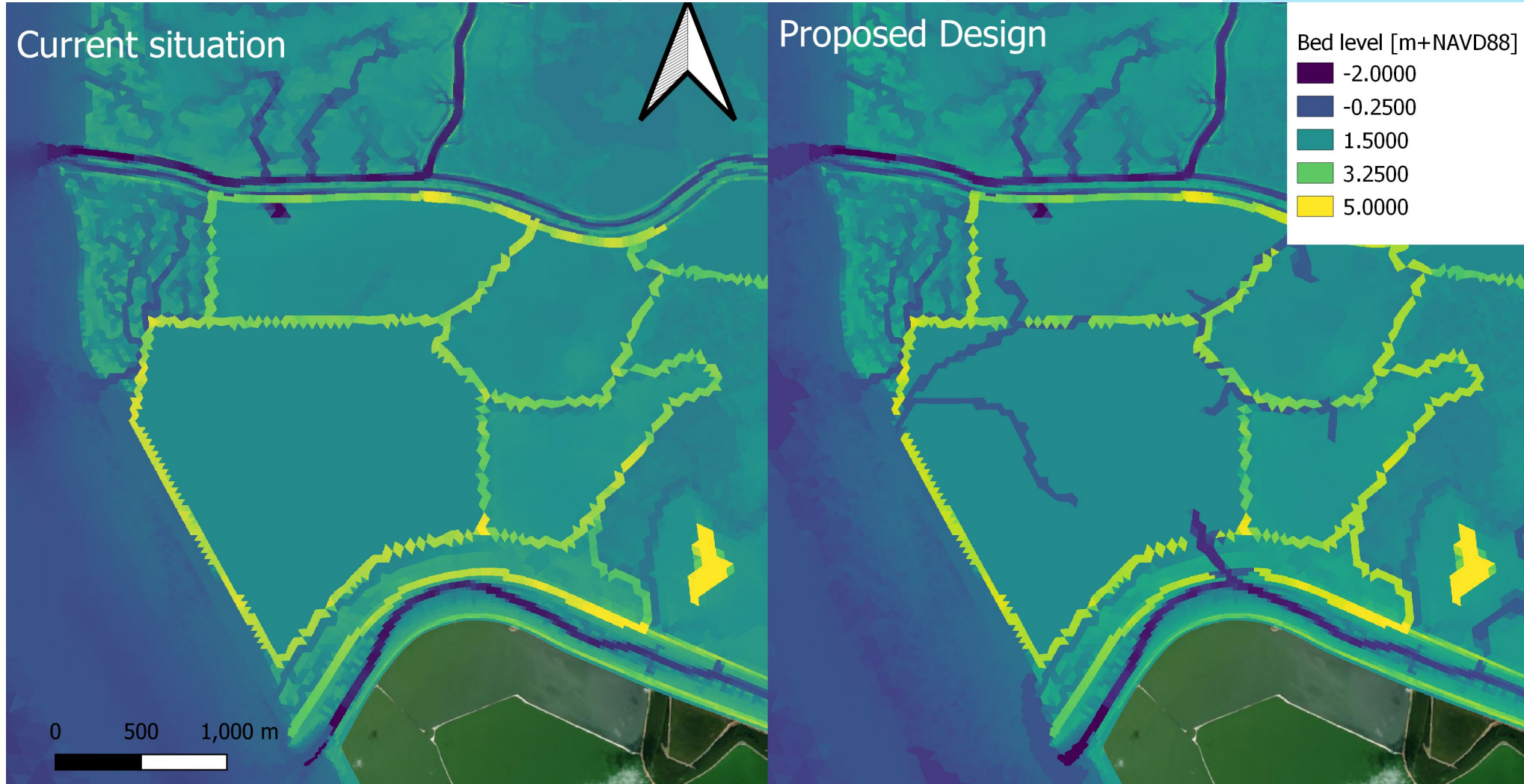


Model setup

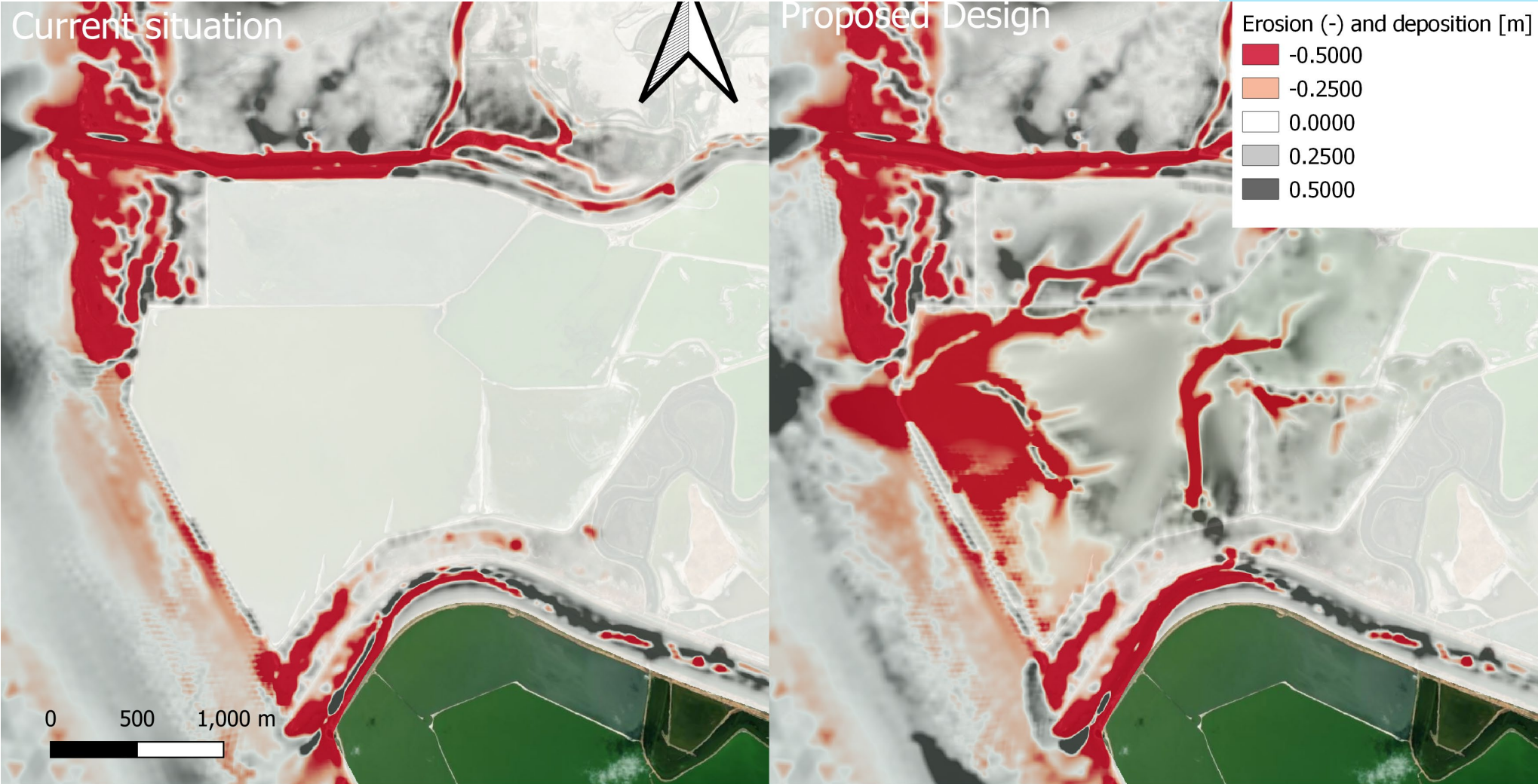
Northern Boundary



Model application: comparison of current situation versus a frontal opening at SF Bay



Computed change in ~50 years with SLR



Next Steps

Future Modeling Efforts

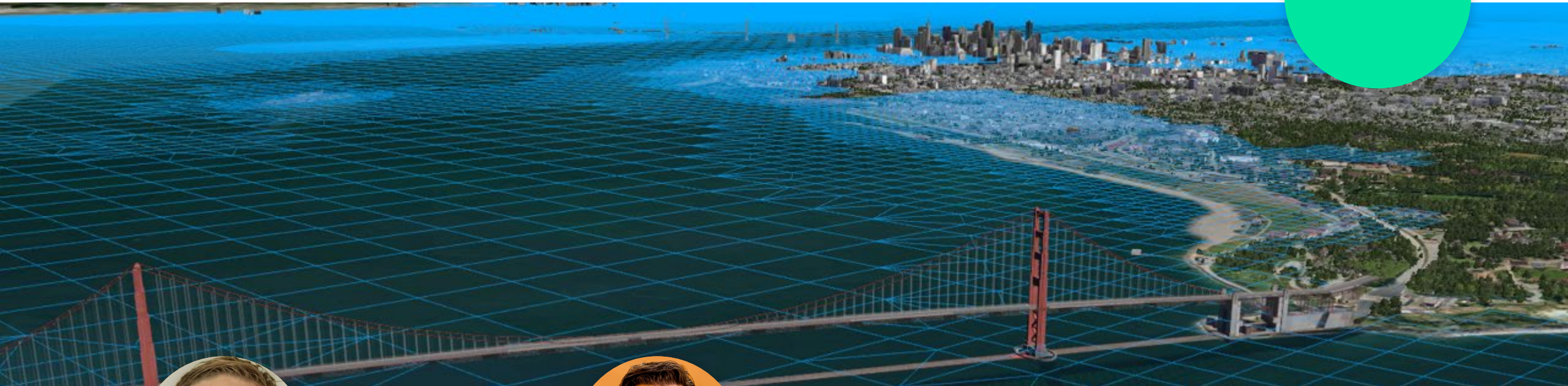
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Next Steps for Community Model

- Publication of Updated SWL Model and Reanalysis
- Nested High-Resolution Model of Lower South Bay
- Wave Model with Downscaled Wind Forcing
- Development of Subregional Groundwater Models
- Online Coupling of Flow, Wave and Groundwater Models

Thank you for your attention!



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